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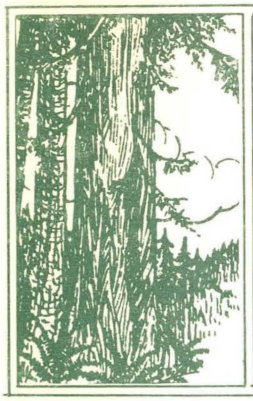

FOREST RESEARCH NOTES

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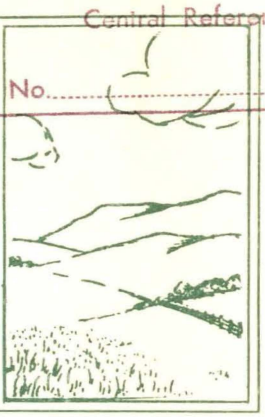

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# SOME ECONOMIC ASPECTS OF GROWING SUGAR PINE IN CALIFORNIA

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By

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* MAINTAINED AT BERKELEY, CALIFORNIA, IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA.

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## Introduction

Because of its technical superiority, sugar pine lumber has always brought premium prices in the lumber market. But because the species is highly susceptible to blister rust and is more difficult to regenerate and carry to maturity than associated species, sugar pine stumpage is also more costly to produce. The basic problem of efficient management for timber production then, is one of how far we are justified in undertaking the special measures needed to grow sugar pine, in the light of the premium values produced and the extra costs of production. How much sugar pine should be grown? How large a forest area is needed to grow this amount of sugar pine? Which particular forest areas should be selected for the purpose? How much will it cost to protect this area from blister rust? What other costs of management will have to be incurred in order to make sure that sugar pine on protected areas can be carried through to maturity? These and related questions indicate the scope of the problem.

## The Need for Research

Answers to most of these questions are not immediately obvious. In the first place, economic research is necessary to determine the nature and extent of sugar pine markets, the degree to which acceptable substitutes for sugar pine are available, the long time trends in the use of sugar pine which may have a bearing on how great future requirements for the species will be, the price premiums which consumers will pay for sugar pine, the extent to which existing industry is dependent on the species for maintaining its profits, the costs of sugar pine production, and the importance of sugar pine to the economic development of the area in which it grows. Such facts can only be determined after careful study. Moreover, insofar as the answers depend on individual judgment as to future conditions, no single set of results can be final.

Of at least equal importance is the need for additional study of the silvicultural techniques necessary to grow sugar pine successfully. The basic research needed as a guide to what these techniques should be has largely been done. Experience with blister rust control and sugar pine management programs in the past 15 years shows clearly that control and management operations are highly interdependent and must be closely correlated if either job is to be done with acceptable efficiency. But to date, we have had no trials of the proposed methods under actual operating conditions. Such trials are essential in order to test the adequacy of the proposed techniques, to work out methods of applying the techniques on operating units and to determine how costly the necessary methods are likely to be.

Research, particularly in management techniques, will obviously have to be carried on for several years before definitive results can be obtained. Meanwhile, public programs concerned with the blister rust problem will continue in operation and administrative decisions governing both the scale of such programs and their application to specific areas will continue to be made. There is thus a pressing need for preliminary study of the blister rust-sugar pine management problem, even though results of such study are recognized as highly tentative.

Purpose and Limitations of this Report

To meet this need, available information on prospective sugar pine market requirements, stumpage values, and production costs has been brought together in this report. Primary attention has been directed to three specific questions:

1. About how much sugar pine will be needed by the time potential second growth crops reach maturity?

2. What is the long run outlook for sugar pine values and for value differentials between sugar pine and other species competing for sugar pine sites?

3. What elements of cost are likely to be most important in determining the spread between costs of growing sugar pine and costs of growing other species on the same site?

Such conclusions as are drawn in this report are tentative in character. Data are not currently available which will permit final decisions on some of the important questions which are involved. Other aspects are currently the subject of intensive research study, results of which may alter or modify views that now seem reasonable. But if these limitations are borne in mind, the results of the present study should prove helpful in formulating policies until such time as more thorough research is available.

## Sugar Pine Forests in California

Economic problems of protecting and managing sugar pine stands must be considered in relation to the present condition of the sugar pine resource. Sugar pine ranges from central Oregon southward through the Coast and Cascade Ranges, the Sierra Nevada, and California cross ranges, into lower California. Its commercial range includes the west side of the Sierra Nevada, the inner Coast Range, the Siskiyou Mountains, and the Southern Cascade range. The species usually occurs in mixed stands. At lower elevations, primary associates are ponderosa pine, incense cedar, Douglas-fir, and oak. Higher up, white and red firs enter the mixture in increasing proportions, and other associates tend to disappear.

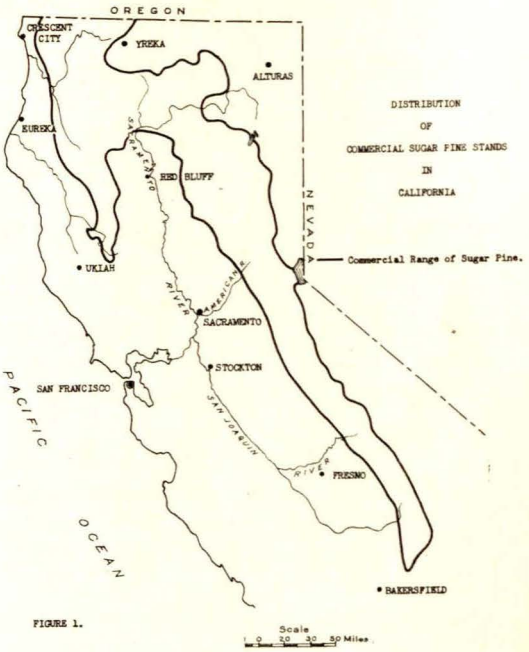

FIGURE 1.

### Sugar Pine Types

For this report, two types of sugar pine forest have been recognized.

a. Sugar pine--fir type: an area in which sugar pine is the key species, forming 15 percent or more of the stand by volume, and in which the volume of firs (true fir or Douglas-fir) is 50 percent or more of total volume, or in which the volume in fir is two or more times the volume in ponderosa pine.

b. Sugar pine--ponderosa pine type: an area in which sugar pine is the key species, forming 15 percent or more of the stand by volume, and in which the volume of firs is less than 50 percent of total volume and less than twice the volume of ponderosa pine.

Sugar pine--ponderosa pine type thus includes not only "pure pine" types, with sugar pine 15 percent or more of the volume, but also stands of sugar pine and ponderosa pine mixed with smaller amounts of Douglas-fir and true fir. Similarly sugar pine—fir type includes not only those areas where ponderosa pine is absent, but also many

mixed stands where ponderosa pine is present in small quantities. As an extreme illustration, an area consisting of 15 percent sugar pine, 34 percent ponderosa pine, and 51 percent firs is classified as sugar pine—fir type under this definition.1/

Area of Sugar Pine Land

The Office of Blister Rust Control has estimated the forest area in sugar pine types in California at 3.1 million acres. This constitutes 18 percent of all timber cropland in the State and 27 percent of the land in pine and mixed coniferous forest types. An additional 2.2 million acres has sugar pine timber on it, but in insufficient quantity to be classed as sugar pine type. About 30 percent of the total acreage is in the southern Sierras (South of the American River, fig. 1). An additional 45 percent is in the northern Sierras, and the remaining 25 percent is in the Coast Range and Siskiyou Mountains.

Complete ownership data have not been compiled. On the basis of Office of Blister Rust Control figures covering over half of the type, however, about 52 percent of the area is in private ownership. The remainder is held largely by the Federal government. Private ownership dominates in the Sierra region with almost 60 percent of the sugar pine land. In the Coast Range and Siskiyous, private owners hold only about 30 percent of the sugar pine area. Throughout the region, 88 percent of the private ownership is in large holdings.

As with ownership, comprehensive data on distribution of the sugar pine area by site quality is not available. Generalized estimates, however (table 1), show that of the total forest area in sugar pine types about one quarter is on high-quality sites (defined as site class I-175 or better). Almost all of this 810 thousand acres of highly productive sugar pine land is in the West Sierra Pine subregion, with only about 50 thousand acres of high-site sugar pine type in the Coast Range.

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1/ This two-fold classification was dictated by the character of the data available for use in this analysis. It does not conform to the type classifications now in general use throughout the region. In particular, it should be noted that the important mixed conifer type is not recognized in the classification used here. Mixed conifer stands running predominantly to fir are here grouped with sugar pine—fir type, and those in which pine predominates are grouped with sugar pine—ponderosa pine type.

Table 1.- Estimated areas of sugar pine type in California by site quality[1/]

(Area in thousand acres)

| Subregion and forest type | Site quality[2/] | | | All sites |
|---|---|---|---|---|
| | High | Medium | Low | |
| East Sierra Pine: | | | | |
| Sugar pine--ponderosa pine | 0 | 45 | 160 | 205 |
| Sugar pine--fir | 0 | 25 | 20 | 45 |
| Total | 0 | 70 | 180 | 250 |
| West Sierra Pine: | | | | |
| Sugar pine--ponderosa pine | 400 | 530 | 50 | 980 |
| Sugar pine--fir | 360 | 460 | 40 | 860 |
| Total | 760 | 990 | 90 | 1,840 |
| Coast Range Pine and Douglas-fir | 50 | 860 | 60 | 970 |
| All Subregions | 810 | 1,920 | 330 | 3,060 |
| Percent of total sugar pine area | 26 | 63 | 11 | 100 |

1/ Estimates based on type maps prepared by Office of Blister Rust Control and data on site quality classes, by forest types and subregions, prepared by the California Forest and Range Experiment Station.

2/ High site includes sites IA-200 and I-175; medium site includes sites II-150 and III-125; low sites include site IV-100 and V-75.

Volumes of Sugar Pine Timber

According to volume estimates compiled by the Experiment Station, the total stand of sugar pine in California in 1945 amounted to 21.1 billion board feet. Of this, 1.6 billion feet was in areas where such factors as topography, accessibility, and character of timber are judged unfavorable for economic operation, at least for a long time to come. About 0.8 billion board feet was in areas of such high recreational value that the usual forms of timber management would not apply and is therefore of doubtful availability from the standpoint of sugar pine supply. This leaves 17.4 billion feet of available sugar pine timber in California (table 2). Fifty-six percent of this volume is in public ownership, and practically all of the publicly-owned volume is on national forests.

Seventy-eight percent of the available volume is in old-growth stands. Most of the remainder is in young growth-old growth stands and

consists principally of residual old growth trees. Sugar pine volumes in young-growth stands amounted to only about 250 million board feet, 1.3 percent of the total available supply. In comparison, almost 5 percent of current ponderosa pine volumes are in young-growth stands. The difference is probably indicative of the difficulties of obtaining sugar pine restocking under past management practices.

As in the case of sugar pine areas, volumes are heavily concentrated in the West Sierra Pine subregion. It contains 73 percent of the total volume. Seventeen percent is in the Coast Range Pine area, and 8 percent in the East Sierra Pine. Volumes in the Douglas-fir and Redwood subregions account for only 2 percent of the total.

Table 2.- Available sugar pine volumes in California by subregion, ownership, and age class of timber

(Volumes in million ft., log scale)

| Subregion and age class | Ownership | | All |
|---|---|---|---|
| | Private | Public 1/ | |
| WEST SIERRA PINE: | | | |
| Old growth | 3,803 | 5,685 | 9,488 |
| Young growth-old growth | 1,508 | 1,499 | 3,007 |
| Young growth | 76 | 146 | 222 |
| All ages | 5,387 | 7,330 | 12,717 |
| EAST SIERRA PINE: | | | |
| Old growth | 874 | 351 | 1,225 |
| Young growth-old growth | 51 | 61 | 112 |
| Young growth | 2 | 6 | 8 |
| All ages | 927 | 418 | 1,345 |
| COAST RANGE PINE, DOUGLAS-FIR, & REDWOOD: | | | |
| Old growth | 1,091 | 1,826 | 2,917 |
| Young growth-old growth | 229 | 145 | 374 |
| Young growth | 17 | 7 | 24 |
| All ages | 1,337 | 1,978 | 3,315 |
| TOTAL CALIFORNIA: | | | |
| Old growth | 5,768 | 7,862 | 13,630 |
| Young growth-old growth | 1,788 | 1,705 | 3,493 |
| Young growth | 95 | 160 | 255 |
| All ages | 7,651 | 9,727 | 17,378 |

1/ Over 98 percent of the publicly owned sugar pine is in National Forests.

Totals may not add because of rounding.

## The Blister Rust Situation

No description of the sugar pine resource would be complete without some reference to the present and prospective effect of white pine blister rust. Once firmly established in an area, this disease quickly causes high mortality in young sugar pine stands. Mature trees suffer much less heavily, but after many years of exposure, these too may be killed. Thus, one of the major factors to be considered in evaluating the sugar pine resource is the extent to which present volumes may be reduced by blister rust damage.

White pine blister rust was discovered in California in 1936 about 14 miles south of the Oregon border. Since then it has spread as far south as San Mateo County on the west and Amador county on the east. The disease has increased in intensity in the northern part of the State to such a degree that the young sugar pines are either dead or dying in many places where control measures have not been adopted. Farther south, it has not yet reached epidemic proportions.

Large scale practical control work was begun in California in 1933 and has continued to the present. Ribes have been removed once from 795 thousand acres of sugar pine land, and additional work to maintain control on these areas has covered 513 thousand acres. Initial work has been completed on 39 percent of the total area included in the control units established by the Office of Blister Rust Control. Control work has been concentrated in the area from Sequoia National Park northward to Plumas National Forest, the optimum range of sugar pine in the Sierra Nevada. Some work has also been done in the Klamath and Lassen National Forests and in Lassen National Park.

The work already done has required 956 thousand man days of effort (to the end of 1947). The Office of Blister Rust Control estimates that, with the methods now in use, an additional 2-1/2 million man days will be necessary to complete the job on the entire 2,044,552 acres in control areas. Costs have risen rapidly from $4 or $5 per man day before the war to about $19 per man day in 1946. Although improved techniques now in sight may well result in some cost reductions, ribes elimination by present methods on the entire 2 million acres in present control areas might thus involve an additional expenditure of 45 to 50 million dollars.

## Sugar Pine Markets and Prospective Requirements

Markets provide the basic economic justification for the production of any commodity. The 3.1 million acres of sugar pine types in California could grow a maximum of perhaps three hundred and fifty million feet of sugar pine timber each year if the necessary management and blister rust control effort were applied. But this would be a

costly undertaking. Unless there is also some likelihood of a market for this amount of sugar pine, at a price sufficient to cover all of the real costs of production, to attempt to grow sugar pine on the entire area would be unwise. It would mean devoting time and money to the production of sugar pine when they could better be used elsewhere. Therefore a look at probable future market requirements for the species is needed as a guide to how much sugar pine we should attempt to grow.

Technical Basis for Market Preference for Sugar Pine

The position of sugar pine as a preferred wood for a number of important uses in the industrial and construction fields is due principally to its physical and working qualities; also, it has been available in large sizes clear of defects.

The wood of sugar pine is typically soft, even-textured, and stays in place well (that is, it shrinks and swells very little with changes in moisture content). It is easily dried with a minimum of degrade due to checking and warping. It works well under power or hand cutting tools. Although the wood is soft and light in weight, it has sufficient strength for the many uses to which it has been applied. Its even texture fits it well for moldings and carvings, and it can be nailed with a minimum of splitting. It provides a good base for paints and enamels.

In general its properties put it in a class with the other white pines, eastern (northern) white pine and western (Idaho) white pine, and the three are used for many of the same purposes. The pattern of lumber industry development in this country has been such that eastern white pine first came into use, then western white, with sugar pine last. Now, however, they are all found in the national market, and are considered as alternate woods for many uses.

Certain other woods, such as ponderosa pine, have gradually become competitive with sugar pine and other white pines for some uses. In some properties ponderosa pine is similar to or approaches the white pines, particularly when the softer, even-textured types of ponderosa pine are selected. It is usually available at lower cost and for some uses has received recognition. This trend may be expected to continue. But for such special uses as foundry patterns, musical and scientific instruments, boot and shoe findings, and special mill-work, the properties of sugar pine remain superior, and the species may well retain its preferred position.

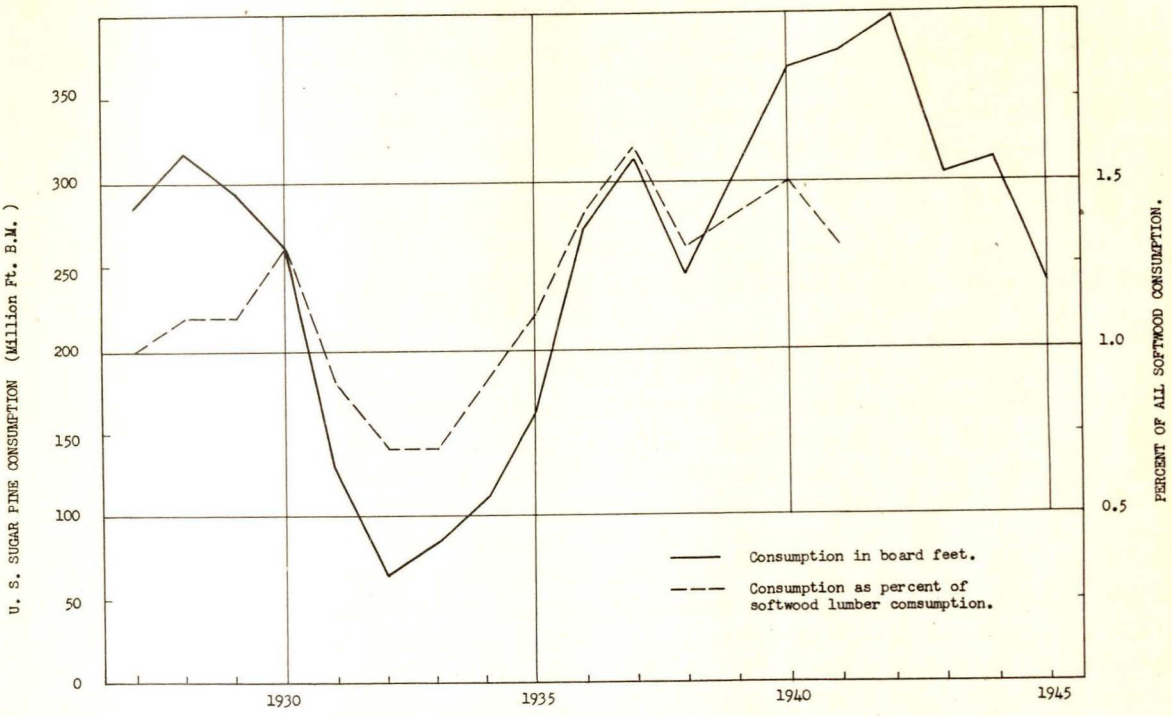



FIGURE 2. CONSUMPTION OF SUGAR PINE LUMBER IN THE UNITED STATES, 1927 to 1945.

## Past Sugar Pine Consumption

Statistics on past consumption of sugar pine lumber are not available, but estimated consumption varies from about 64 million board feet consumed in 1932 to almost 400 million board feet in 1942, a six-fold increase (fig. 2). During the 19-year period for which estimates are available, consumption averaged 256 million board feet per year. Because of the pronounced influence of war conditions on recent lumber needs, it is difficult to establish any normal consumption trend from the data in figure 2. However, it is worth noting that in 1937, (a year of only moderate prosperity), sugar pine consumption was almost equal to that in 1928, a very prosperous year marked by heavy demand for lumber. The historical data thus seem to point toward a generally upward trend in total sugar pine consumption.

Although some variation occurs from year to year, sugar pine consumption normally has amounted to about 1.2 percent of all softwood use. In the producing area, of course, the relative

importance of the species in the softwood market is much greater. But even there it is a secondary species from the volume standpoint, and special measures to grow sugar pine will find little justification on the basis of relative market volumes. The importance of sugar pine in the market depends rather on the uses to which it has special adaptation.

Principal Uses and Their Relative Importance

Sugar pine lumber has been consumed for (1) specialty uses, such as pattern making, sash and door manufacture, and instrument making, where the peculiar properties of sugar pine give it superior adaptability for the purpose; and (2) general uses, such as box manufacture, planing mill products, and light construction, where the special properties of sugar pine are considerably less significant. A general indication of the relative quantitative importance of these two types of use can be obtained by comparing sugar pine lumber used in manufacture in 1933 and 1940 with total sugar pine consumption (fig. 3). In each of the years for which information is available, specialty uses accounted for 32 percent of total consumption. As 1933 was a year of deep depression and 1940 one of pre-war prosperity, there is reason to feel that the proportions displayed by the data are fairly stable.

For the principal general uses, box manufacture and light construction, sugar pine comes into full competition with ponderosa pine as well as with other species, and its special qualities are of no particular advantage. Moreover, common grades comprise by far the greater proportion of the sugar pine consumed in these uses. As such, they are of below average unit value and, in most cases, are not even distinguished from ponderosa pine in the marketing process.

Thus, so far as two-thirds of the volume of sugar pine consumption is concerned, there is little to distinguish it from ponderosa pine. In contrast with Douglas-fir and true firs, sugar pine has some margin of technical superiority in this general market. But with proper methods of handling and with due recognition of the inherent characteristics of fir woods, this margin will probably narrow as time goes on.

Sugar pine is only a small element in this general market. Comparison of the 250 million board feet of sugar pine consumed in general uses in 1940 with the total size of the box lumber, planing mill, and light construction markets makes it clear that this species could only provide for a small proportion of the total consumption in these lines. The market is thus dominated by other species. Even though sugar pine commands a price premium for planing mill use, it seems safe to say that the general market would suffer little inconvenience or economic loss if sugar pine were replaced by ponderosa pine, or some other suitable species.

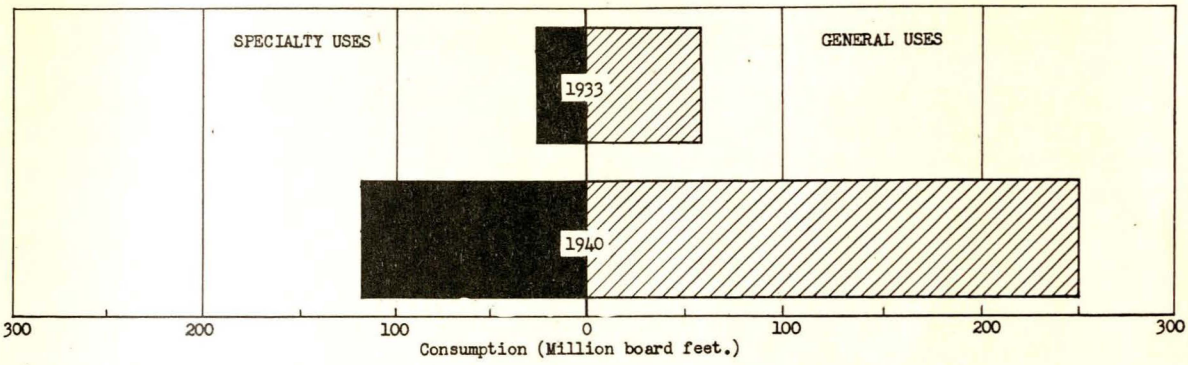



FIGURE 3. DISTRIBUTION OF SUGAR PINE LUMBER CONSUMPTION BETWEEN SPECIALTY AND GENERAL USES, 1933 and 1940.

Thus, the market which places primary reliance on sugar pine is the specialty use market. In 1940 about 120 million feet of sugar pine went into these specialty uses (table 3). Ninety-nine percent of this amount was used by six manufacturing industries: sash, doors, and general millwork; patterns and flasks; shade and map rollers; boot and shoe findings; scientific instruments; and musical instruments. Of these, millwork and patterns are the only volume consumers, taking over 93 percent of all sugar pine used in manufacture.

Table 3.- Major manufacturing specialty uses of sugar pine- 1940

| Manufacturing use | Volume of lumber used in 1940 in M ft. b. m. | | | | |
|---|---|---|---|---|---|
| | Sugar pine | Other white pine | Ponderosa pine | All other softwoods | Total softwood use |
| Sash, doors, and general millwork | 90,239 | 53,009 | 852,126 | 648,327 | 1,643,701 |
| Patterns and flasks | 21,413 | 41,846 | 2,241 | 16,336 1/ | 81,836 |
| Shade and map rollers | 2,893 | 7,033 | 8,016 | 682 | 18,624 |
| Boot and shoe findings | 2,278 | 4,530 | 124 | 240 | 7,172 |
| Scientific instruments | 664 | 162 | 1,419 | 562 | 2,807 |
| Musical instruments | 655 | 158 | 212 | 3,815 | 4,840 |
| Woodenware and novelties | 245 | 1,139 | 3,662 | 6,305 | 11,351 |
| Ship and boat building | 244 | 3,174 | 899 | 56,851 | 61,168 |
| Fixtures | 204 | 2,001 | 8,780 | 18,798 | 29,783 |
| Car construction and repair | 158 | 1,522 | 1,361 | 485,825 | 488,866 |
| Airplanes | 105 | 157 | 24 | 7,466 | 7,752 |
| All other manufacturing uses 2/ | 389 | 117,821 | 135,074 | 761,287 | 1,014,571 |
| Total manufacturing use 2/ | 119,487 | 232,552 | 1,013,938 | 2,006,494 | 3,372,471 |

1/ Used largely for flasks.
2/ Excluding box, basket, and crate manufacture.
Source: U.S.D.A. Forest Service. Lumber Used in Manufactures - 1940.

Competitive Position of Sugar Pine in Different Uses

Although sash, doors, millwork and foundry patterns provided the principal manufacturing uses from the standpoint of volume, the picture is somewhat different when viewed from the standpoint of the relative importance of sugar pine to each of the industries in question (table 4).

Table 4.- Sugar pine and white pine consumption in selected manufacturing uses in relation to total softwood consumption - 1940

| Manufacturing use | Total softwood consumption | Percent of total softwood consumption which was — | | |
|---|---|---|---|---|
| | | Sugar pine | Other white pines | All white pines |
| | M ft. b. m. | | | |
| Patterns and flasks | 81,836 | 26.2 | 51.1 | 77.3 |
| Patterns only (estimated) | 65,000 | 32.9 | 64.4 | 97.3 |
| Boot and shoe findings | 7,172 | 31.8 | 63.2 | 95.0 |
| Scientific instruments | 2,807 | 23.7 | 5.8 | 29.5 |
| Shade and map rollers | 18,624 | 15.5 | 47.8 | 63.3 |
| Musical instruments | 4,840 | 13.5 | 3.3 | 16.8 |
| Sash, doors, & general millwork | 1,643,701 | 6.6 | 3.2 | 8.7 |
| Woodenware and novelties | 11,351 | 2.2 | 10.0 | 12.2 |
| Airplanes | 7,752 | 1.4 | 2.0 | 3.4 |
| Fixtures | 29,783 | 0.7 | 6.7 | 7.4 |
| Ship and boat building | 61,168 | 0.4 | 5.2 | 5.6 |
| All other manufacturing uses* | 1,503,437 | negl. | 7.9 | 7.9 |
| Total manufacturing uses* | 3,372,471 | 3.5 | 6.9 | 10.4 |

*Excluding box, basket, and crate manufacture.

The data bring out the fact that softwood lumber requirements for boot and shoe findings, patterns, and shade and map rollers are largely met by the use of white pine, and in each case sugar pine holds a substantial part of the market.

Of the 81.8 million feet of softwood used in patterns and flasks, 20 percent consisted of Douglas-fir, southern yellow pine and spruce, used primarily for flasks. Thus, for pattern work alone, only 65 million feet of softwoods were used and this need was met almost

entirely by the white pines. Some ponderosa pine and a small amount of redwood also enter into pattern manufacture. Although some lower grade lumber of these species goes into flasks, their principal use here is in foundry patterns.

For scientific and musical instruments, and for woodenware and novelties, white pines supply less than 50 percent but more than 10 percent of total softwood use. They are thus major sources of supply for these industries even though they do not dominate the picture. Sugar pine is definitely favored over other white pines for instruments, but holds only 2 percent of the woodenware and novelty market. For sash, doors, and general millwork, white pines account for less than 9 percent of total consumption, but sugar pine appears to be in a preferred position with respect to other white pines.

In each of the other tabulated manufacturing uses sugar pine provides a negligible proportion of total softwood supply so far as the user industries are concerned. Some 5 million feet of eastern and western white pine went into fixtures and ship and boat building in 1940, but sugar pine supplied less than one-tenth of this volume to these industries.

It is worthy of note that, although a negligible percentage of softwood requirements for "All other manufacturing industries" was met from sugar pine, almost 118 million board feet of other white pines were used by this group in 1940. The principal items involved were western white pine for match blocks (74 million feet) and eastern white pine for caskets and toys (16 million feet).

The market pattern may be summarized by grouping together those industries where sugar pine is in a dominant, co-dominant, or subordinant position (table 5). About one-fourth of the tabulated volume of manufacturing use of sugar pine falls in the "dominant" and "co-dominant" groups. In view of the very definite expression of market preference for white pine reflected in table 4, loss of a sugar pine supply would undoubtedly be of serious consequence to users in these groups. The volume of such use can therefore be regarded as a rough measure of high priority market requirements for the species. In 1940 this amounted to 28 million board feet, practically all of it in Clear and Shop grades.

Table 5.- Classification of markets for sugar pine in manufacturing uses

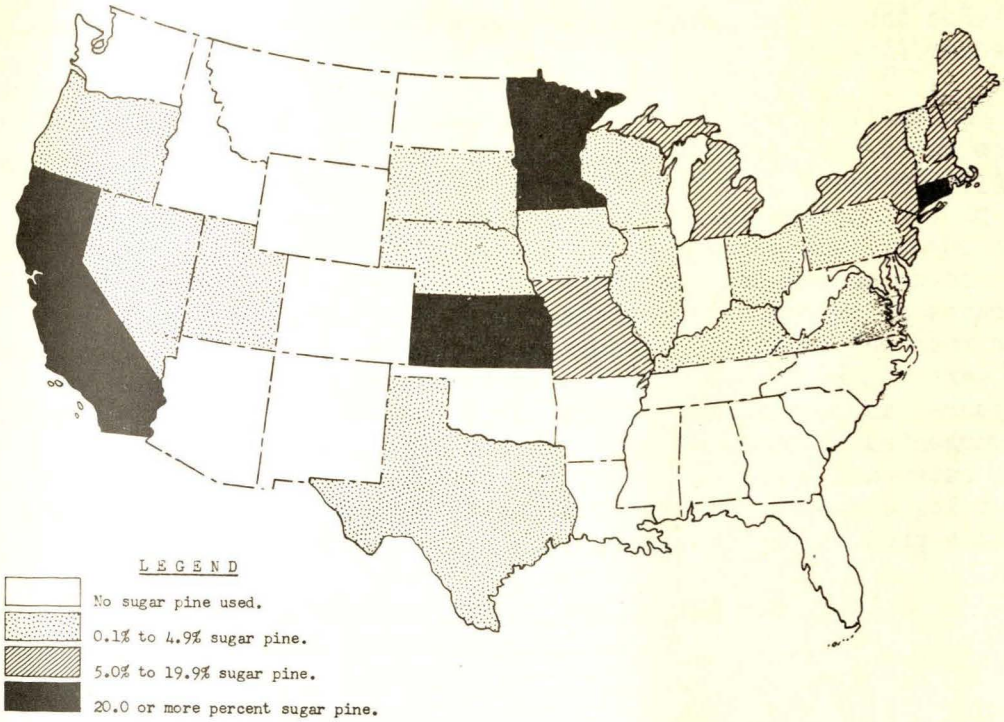
| Type of market | 1940 Consumption | |
|---|---|---|
| | Sugar pine | Other white pine |
| | Million ft. b. m. | |
| Sugar pine dominant | 24.4 | 46.5 |
| Sugar pine co-dominant | 3.5 | 7.2 |
| Sugar pine secondary | 90.6 | 54.3 |
| Sugar pine negligible | 1.0 | 124.6 |
| All manufacturing markets* | 119.5 | 232.6 |

*Excluding box, basket, and crate manufacture.

Where sugar pine occupies a secondary position in the market it is more difficult to assess market "needs" for the species objectively. This sector involves primarily the use of sugar pine for sash, door, and general millwork manufacture. For this purpose, ponderosa pine and Douglas-fir are the dominant species, accounting for 52 percent and 22 percent of 1940 softwood consumption respectively. A closer examination of the use of sugar pine in this line of manufacture indicates that, despite its over-all secondary importance, sugar pine approaches a dominant position in particular market areas (fig. 4).

Sugar pine is in a very strong position in the Northeastern, Lake, and sugar pine producing states. In the Middle Atlantic and Central States it is of secondary importance. Elsewhere (except in Kansas) it is a negligible factor in the market. Using the same general criteria of dominance and co-dominance which were applied in deriving table 5, sugar pine appears in a co-dominant or better position with respect to the sash, door, and general millwork market in the following states: Minnesota, Connecticut, California, Kansas, Maine and New Hampshire.

These six states used 246 million feet b. m. of softwood lumber for sash, door and general millwork manufacture in 1940 of which 71 million feet, or 29 percent, was sugar pine. This figure may be regarded as measuring a second element in market needs for the species, of lower priority than that required for other manufacturing uses.




SUGAR PINE USE AS A PERCENT OF TOTAL SOFTWOOD LUMBER USE.

SASH, DOOR AND MILLWORK MANUFACTURE, 1940....

FIGURE 4.

Most of the sugar pine used in the manufactures discussed in the preceding paragraphs is of shop or select grades. It represents premium quality material. Production of the indicated quantities of these grades will, of course, generate corresponding quantities of lower grade lumber. On the basis of 50 percent grade recovery in shop and selects, the estimates of minimum market needs for specialty uses imply total minimum sugar pine needs of about 200 million board feet per year under 1940 conditions. Of this amount, 56 million board feet per year of output would have been required to meet the need for upper grades in the high priority manufacturing uses.

## Supplies of White Pine Competitive with Sugar Pine

Although it has become of increasing relative importance, the supply of sugar pine lumber has always represented a minor portion of total white pine lumber supply when measured in quantitative terms. Despite catastrophic declines in its production, eastern white pine lumber output has always exceeded that of other white pine species,

except for the decade 1931-1940 when western white pine was generally the leader (fig. 5).

As implied by the trend of the production data, however, eastern white pine seems likely soon to lose its leadership, even on a quantitative basis. Of the three major white pine species eastern white pine comprises less than a fourth of the remaining total saw timber supply, and western white pine about a third (table 6). Forty-four percent of remaining white pine saw timber is sugar pine. At 1944 rates of output, New England and Middle Atlantic States saw timber represented only 9.5 years cut. Comparable figures for other areas were: Lake States, 13.3 years; western white pine region, 55.7 years; and sugar pine region, 72.0 years. Although the relationship suggested by these figures ignores differences in regional growth rates and gives no credit for stands which are now of less than sawlog size, it seems highly probable that eastern white pine must lose production leadership within a relatively few years.

Table 6.- White pine saw timber supplies in the U. S. by species and location[1/] 1945

(Volumes in billions of board feet)

| Species and location | Saw timber volume | |
|---|---|---|
| Eastern white pine: | | |
| New England | 6.3 | |
| Middle Atlantic | 2.3 | |
| Lake States | 2.6 | |
| Other areas | 1.3 | |
| Species Total | | 12.5 |
| Western white pine: | | |
| North Idaho and Montana | 12.6 | |
| Elsewhere | 4.5 | |
| Species Total | | 17.1 |
| Sugar pine: | | |
| California | 19.5 | |
| Oregon | 3.4 | |
| Species Total | | 22.9 |
| Grand Total — All white pines | | 52.5 |

1/ Volumes in withdrawn areas, such as National Parks, have been excluded.

Source: U. S. Forest Service, Washington, D. C.

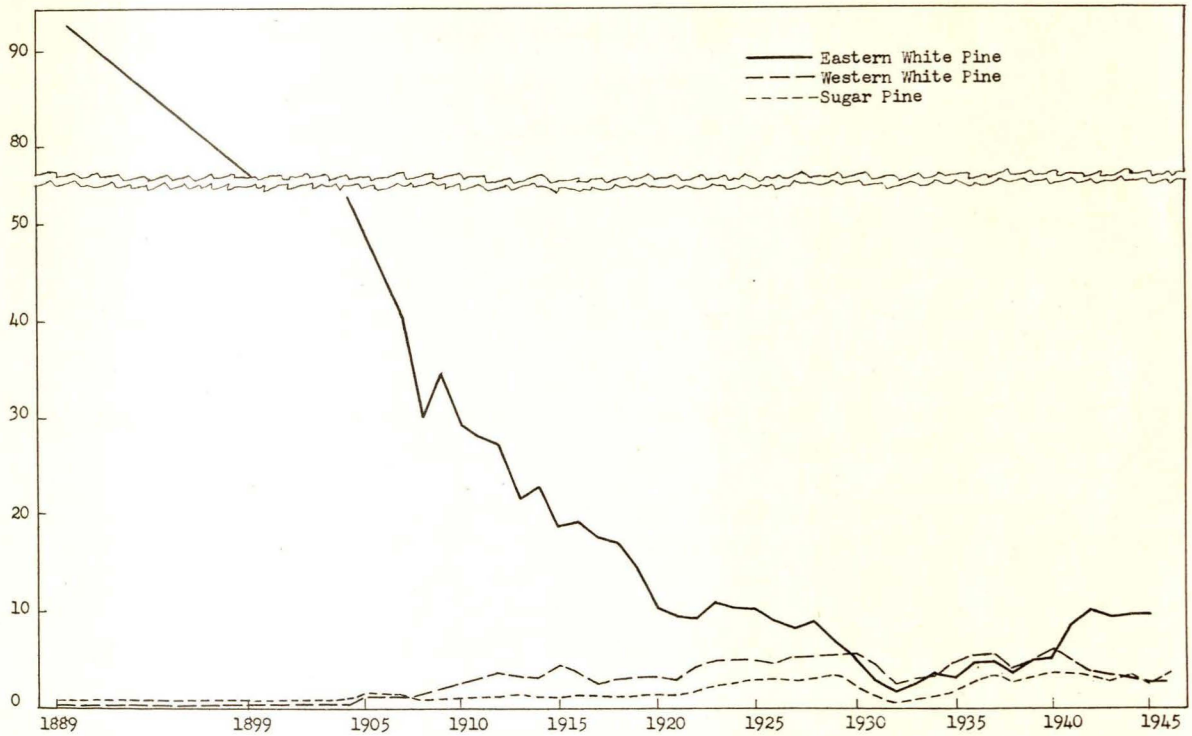



FIGURE 5. WHITE PINE LUMBER PRODUCTION IN THE U. S., BY SPECIES, 1889 - 1946.
Source: U. S. Census Bureau and Forest Service production surveys..

On a quality basis, sugar pine lumber supplies have been relatively much more important. Since the turn of the century, eastern white pine production has been increasingly from second growth and low grade residual stands. Data on percentages of output currently recovered in various lumber grades are not available for the eastern white pine regions. But a study of grade recoveries from butt logs of eastern white pine trees cut in New England in the middle 1930's showed that 86 percent of the board foot volume was in #2 Common or poorer grades. Only one and one-half percent of the total was in Select or better grades.

In contrast, grades and woods reports of the Western Pine Association indicate about 18 percent of western white pine and 22 percent of sugar pine is recovered in Select or better grades. In addition, about 2.5 percent of the lumber yield from western white pine and 27 percent of that from sugar pine is in Shop grades. If these percentages are representative, sources of white pine supply, by grade groups, looked something like this in 1945:

| Grade Group | Percent of total supply from - | | | |
|---|---|---|---|---|
| | Sugar pine | Western white pine | Eastern white pine | Total |
| Selects | 48 | 43 | 9 | 100 |
| Shop | 91 | 9 | 0 | 100 |
| Common | 9 | 16 | 75 | 100 |
| All Grades | 16 | 17 | 67 | 100 |

Thus, despite the fact that sugar pine ranked third among white pine species in total production, it dominated the market supply of Select and Shop lumber.

It seems clear that, so long as old growth stands hold out, sugar pine will remain the principal source of high quality material. But the situation may be less favorable for the long run period with which the problem of blister rust control is concerned. In this time, high quality stands of old growth timber in the West will have mostly been cut. All producing regions will be relying on second growth stumpage. Supplies of select white pine lumber will be limited to what can be produced through silvicultural practice. Shop grades, as now conceived, will probably no longer be produced in quantity.

Under such circumstances, eastern white pine may again play a more prominent role in the quality lumber market. The major factors which will determine the source of quality white pine timber will probably then be the relative rates at which white pine can be grown in different regions, the area available for such growth, the costs of silvicultural practices, and the extent to which different regions have maintained a high quality white pine growing stock.

Precise evaluation of the long-run comparative advantage of different white pine producing regions cannot be made. But certain regional differences can be recognized on the basis of the criteria listed above. Rates of growth are slower in the Northeast and Lake States than they are in California or in the western white pine region of Idaho. On the other hand, the areas in eastern white pine types account for about two-thirds of all white pine acreage in the United States (table 7).

Table 7.- Forest land areas in white pine types in the United States

| Type and location | Area | | Percent | |
|---|---|---|---|---|
| | (Millions of acres) | | | |
| Eastern white pine types: | | | | |
| Northeast | 7.0 | | 33.6 | |
| Lake States | 2.0 | | 9.6 | |
| Southern Appalachian | 4.5 | | 21.6 | |
| Total Eastern white pine types | | 13.5 | | 64.8 |
| Western white pine types: | | 3.7 | | 17.9 |
| Sugar pine types: | | | | |
| California | 3.1 | | 14.9 | |
| Oregon | 0.5 | | 2.4 | |
| Total sugar pine types | | 3.6 | | 17.3 |
| Grand Total All white pine types | | 20.8 | | 100.0 |

Source: Office of Blister Rust Control

With respect to costs of silvicultural practices, sugar pine appears to be at a disadvantage because of difficulty in establishing it and of the need for continued treatments to free it from competition of other species. An additional element in costs stems from the fact that both eastern and western white pine can ordinarily be grown in stands which approach pure white pine type much more closely than can sugar pine. As costs of blister rust control are not materially affected by the proportion of white pine in the stand, costs per thousand feet of white pine produced will be less, other things being equal, for areas with a high percentage of white pine in the stand than for areas with a low percentage. This factor is probably offset only in part by heavier total volumes per acre obtained in sugar pine types.

Unlike the Northeast and the Lake States, California and the Inland Empire are still in a position to convert considerable portions of their white pine stands to high-quality forest growing stock at comparatively low cost. In eastern white pine areas, significant volumes of high-quality growing stock will only be achieved after heavy investment in stand rehabilitation and a very long period of waiting. In much of the West we still have a large volume of good growing stock

on the ground and are in a position to add to it at comparatively low cost by proper methods of cutting in remaining virgin stands. This advantage is undoubtedly of paramount importance at the present time. But it is being dissipated so long as management practices in use in the woods fall short of those necessary to maintain a high grade sugar pine stand.

In sum, the long run outlook for white pine supplies indicates that because of favorable rates of growth and relatively undepleted condition of growing stock, the sugar pine region should be able to compete successfully with other areas of white pine production, provided existing old-growth stands are cut with the definite objective of maintaining sugar pine growing stock.

## The Long-run Market Outlook

Lumber markets have always been characterized by a high degree of competition, both between different species of wood and between lumber and nonwood substitutes. Under such circumstances, continuity of supply is essential to maintenance of the market for any given lumber item. Reductions in the available supply of sugar pine will, if extended over a period of years, lead to general adoption of other species or other materials by important segments of the present sugar pine market. Once lost, many of these markets would be extremely difficult to reestablish even if the supply of sugar pine improved. New patterns of buyer preference would have become established which would mitigate against, rather than favor, the use of sugar pine.

In other words, an important determinant of long-run sugar pine requirements will be the future course of sugar pine supplies. If these supplies can be maintained at present levels, future requirements will be larger than if a period of reduced supplies must intervene before the full effects of timber management policies can make themselves felt.

### Adequacy of Prospective Sugar Pine Supplies

Existing sugar pine stands (table 8) appear barely adequate to maintain supplies through the necessary period of transition to a managed basis.

During the past two decades, an average of 250 million board feet of sugar pine has been cut each year. The existing available stand of almost 21 billion board feet could sustain this average cut for about 85 years. Detailed analysis has not been made, but it seems likely that future growth on young and residual stands would provide enough additional supply to maintain output at the 250 million feet per year level for at least an additional twenty years.

Table 8.- Sugar pine saw timber volumes

(as of January 1, 1945)
(in billion ft. b. m. )

| | California | Oregon 1/ | Total |
|---|---|---|---|
| Total saw timber | 21.0 | 3.5 | 24.5 |
| Available saw timber | 17.4 | 3.4 | 20.8 |
| Old growth stands | 13.6 | 2.9 | 16.5 |
| Young growth and residual stands | 3.8 | 0.5 | 4.3 |

1/ Data supplied by Pacific Northwest Forest and Range Experiment Station.

Ability to maintain sugar pine supplies during the period required to build up a satisfactory sugar pine growing stock may thus be one of the most critical factors in determining future sugar pine requirements. There are numerous indications that saw-timber drain from California pine forests is likely to be maintained during the next few decades at considerably higher levels than those experienced in the past. If so, and if sugar pine comprises a normal proportion of this drain, the old-growth reserve of the species will be used up in considerably less than the 85-year period indicated above. Unless management programs are adequate to insure future supplies by the time the old-growth sugar pine stand has been removed, future market requirements may fall far below what current conditions would otherwise indicate.

The foregoing analysis implies the need for a blister rust control program designed to protect old-growth stands to the extent necessary to permit orderly liquidation of existing virgin sugar pine. If blister rust were not controlled, it seems probable that heavy losses of virgin timber would occur within 35 to 50 years. In order to avoid such losses it would be necessary to liquidate the old growth stand much more rapidly than would be consistent with perpetuation of sugar pine supplies. It is conceivable that such liquidation might be forced to the point where high grade sugar pine was being cut in greater volume than normal specialty markets could absorb.

The prospect of such a situation justifies enough blister rust control in old growth stands to keep damage to virgin timber below levels which would lead to accelerated liquidation. Such a program

would probably involve careful selection of those areas of virgin timber which, at normal rates of cutting, would not be harvested until after significant blister rust losses had been incurred, and adoption of adequate control efforts in such areas. The costs of such a program could logically be charged entirely to the virgin stand.

Prospective Trends in Sugar Pine Requirements

The preceding analysis of sugar pine consumption has provided at least a rough basis for evaluating past minimum market needs for the species. When we look to the future, however, we are on much less certain ground, particularly when we take into view the lengthy period of sugar pine production which is an essential element in the blister rust problem. About all we can do is to point out the major factors which may cause changes in present levels of need, and indicate wherever possible the probable future trends of these factors.

An important variable affecting quantities of sugar pine needed at any time is the general level of economic activity and manufacturing output in the country. National income (adjusted to a dollar of constant purchasing power) provides a convenient index of the general level of economic activity. From 1860 to 1910 real national income doubled about every 20 years. From 1910 to the present it has doubled about every 30 years. In the light of this a further doubling between 1940 and the end of the present century would seem a conservative assumption, particularly in view of war-time experience with income and output. This would mean a minimum national income of $150 billion in 1940 prices to be achieved by the year 2000.

We cannot of course predict the effect of such an expansion in production on sugar pine markets. We can say with some assurance, however, that, in the absence of countervailing factors, such a doubling of real income will have a very pronounced expansive influence on them.

Current trends in population growth and industrial development are tending to build up markets close to areas of sugar pine production faster than in areas of older economic development where the species is at a competitive disadvantage. There is every evidence to indicate that these trends will continue to operate for a long time to come. Insofar as they do, they will exert a further expansive influence on sugar pine markets.

Another factor likely to be important reflects the reduction in tree quality that will inevitably accompany liquidation of existing virgin stands. As more and more of the total sugar pine cut comes from second growth, the percentage of lumber recovered in upper grades will fall below current yields from old-growth timber (estimated at 50 percent). Future recoveries of upper grades are unlikely to exceed 35 percent of total cut. Under such circumstances a larger volume of

standing timber will be required to meet given needs for high quality material. For example, to meet the "minimum 1940 market need" for quality material (estimated at 100 million feet) would then require production of 285 million feet of sugar pine timber, or 40 percent more than was required for production of the same amount of quality material in 1940.

Offsetting this are other trends which lead to a reduction in wood use. Two major trends of this sort should be considered. One involves the development and use of some new material to replace wood in a given use. Development of such substitutes depends on technological change and cannot be forecasted. About all we know is that the rate of such change as it affects use of sugar pine will certainly be influenced by relative prices for sugar pine lumber. If increasing scarcity of sugar pine leads to significantly higher real prices for the species than those experienced in the past we may well expect more substitution. On the other hand, in considering the likelihood of this possibility, it should be borne in mind that many potential substitutes are derived from sources of supply which are definitely limited. For example, as time goes on and our metal reserves are reduced, the tendency to replace wood by certain metals could conceivably be reversed. Because of its high quality sugar pine may be one of the first woods to profit from such a development.

A second factor which, in the past, has resulted in a decline in wood use, has been a shift in the market away from certain types of goods in which wood is an important component. Residential construction is an outstanding example. Slowing down of population growth simply reduced the aggregate size of the housing market. This factor seems likely to continue to operate as population stabilizes. However, there are few uses outside of the residential construction field where this type of thing seems likely to occur, and, as noted above, sugar pine provides only a small proportion of total lumber consumed in construction.

In summary, the long run demands for sugar pine will be largely the resultant of a powerful expansive force generated in response to normal growth of the national economy, an increase in prices due to reduced white pine supplies, and certain unpredictable but probable reductions in the market resulting from substitution and changes in the character of human wants. In the face of these conflicting trends, if an estimate of future sugar pine requirements must be made, it seems proper to place the figure somewhat above the estimated 1940 minimum needs. An estimate of 250 million board feet total annual needs by the year 2000 appears reasonable. Of this, perhaps 70 million feet, most of it high quality material, would be required to supply manufacturing industries where sugar pine now holds a key position in the market.

For a number of reasons, these appear to be conservative goals. Assuming that our estimate of general economic growth is approximately

correct, the goals imply that only half as much quality sugar pine will be required, for a given volume of economic activity, as was used in 1940. The goals make no allowance for the possibility that sugar pine may be called on to meet demands for needs now being filled by other white pine species, which may prove less able to compete under the handicap of blister rust control than sugar pine itself. They make no allowance for expansion of wood use in currently unimportant lines of consumption. Finally, they make no allowance for the very considerable market development which may take place in response to improved methods of wood utilization, and fundamental advances in wood technology.

Available evidence suggests that market demands for sugar pine would equal or exceed the 250 million foot level, under conditions of full employment, even in the face of an increase in real prices of sugar pine uppers equal to a quarter or more of current values.

## Trends in Sugar Pine Values

### Stumpage Prices

Average stumpage price data for sugar pine and other species in California are available for most of the last quarter century. Caution must be used in interpreting such data, however, because average stumpage prices are based on quotations covering widely differing timber tracts. The prices reflect differences in quality and accessibility, as well as differences in basic values. For this reason, the data are primarily of use in studying long run relationships, where quality and accessibility factors may tend to average out. Year-to-year comparisons probably have little meaning.

Data on average prices of both private and public stumpage sales have been analyzed. As major movements of both sets of sugar pine stumpage values are usually consistent, the price series for public stumpage will be used in further analysis because more complete data are available covering such transactions.

Long run trends in values should be measured in terms of dollars of constant purchasing power. Price changes which merely reflect general inflationary or deflationary developments are not significant in evaluating the long run market outlook. Therefore, stumpage prices reported for National Forest timber sales were converted into "real" prices in terms of 1926 dollars (fig. 6).

The year-to-year variations in average real stumpage prices have been very large. But it should be remembered that these are due in part to year-to-year variations in quality and accessibility of timber sold. Despite these fluctuations, the data give a definite indication of an upward trend of about 8 percent per decade in the real price of sugar pine.

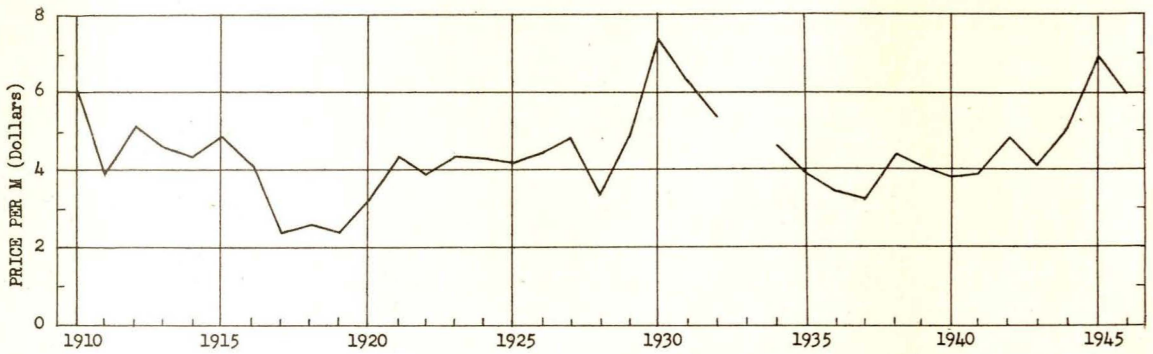



FIGURE 6. WEIGHTED AVERAGE ANNUAL SUGAR PINE STUMPAGE PRICES IN CALIFORNIA NATIONAL FOREST TIMBER SALES, 1910 - 1946.
(Adjusted to dollars of constant purchasing power. Base Year = 1926.)

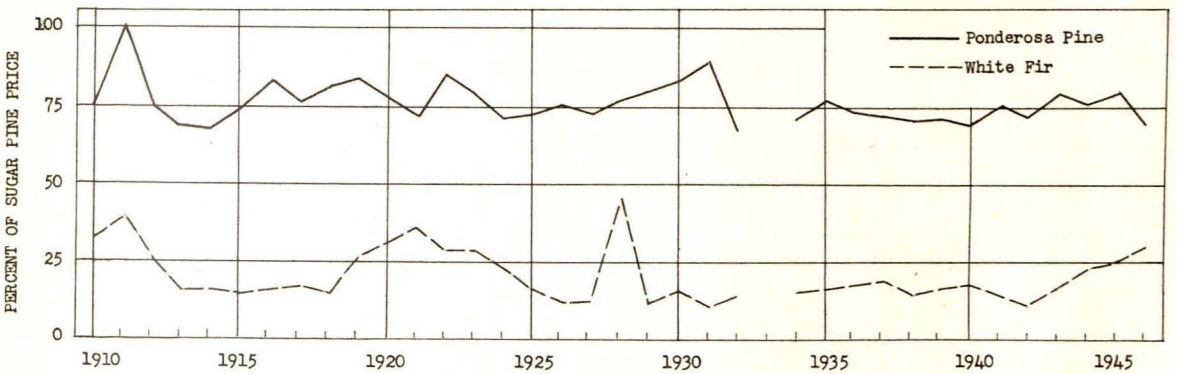



FIGURE 7. AVERAGE ANNUAL PONDEROSA PINE AND WHITE FIR STUMPAGE PRICES AS A PERCENT OF SUGAR PINE PRICE.

From the standpoint of problems of sugar pine management and blister rust control, the amount and trend of the stumpage price differentials between sugar pine and other species competing for the same site is just as important as the general trend of stumpage prices as a whole. To avoid the bias which enters into a simple comparison of weighted average prices, the data for 248 National Forest timber sales of mixed species including sugar pine, covering 1.5 billion feet of sugar pine timber, were analyzed in the following way. For each sale, stumpage prices of each species were expressed as a percentage of the stumpage price of sugar pine applicable to that sale. Annual average percentages were then calculated by weighting the percentage for each sale by the volume of sugar pine included in the sale. The resulting figure expresses the average percentage relationship between sugar pine stumpage values and those of other species (fig. 7).

For the 37-year period 1910-1946 the observed stumpage price differentials have been rather consistent. (In the years of widest deviation from trend, such as 1911, 1914, 1928 and 1931, relatively small volumes of sugar pine were sold). For all 248 sales in the period, the ponderosa pine stumpage price averaged 76.5 percent of the sugar pine stumpage price. Fir averaged 20.8 percent.

There was a small but recognizable tendency for the differential favoring sugar pine to increase with respect to both ponderosa pine and fir. From 1910 to 1919, ponderosa pine prices averaged 78.3 percent of sugar pine, but by 1940-1946 they averaged only 74.6 percent. During the same interval, the corresponding percentages for fir fell from 20.5 to 16.9. In connection with the latter species it should be noted that from 1925 to 1942 almost all National Forest timber sales were made at the minimum statutory price of $.50 per M. This has the effect of increasing the ratio of fir to sugar pine prices during this period above what it would have been in the absence of a floor under fir prices.

Although the evidence is thus fairly convincing that the stumpage price differential between sugar pine and other species competing for the site has widened, the rate at which the spread has increased in the past has been so small as to be of little practical significance. In the case of fir, the last four years have seen a steady reduction of the differential, but it may be premature to interpret this as a reversal of the long time trend.

Lumber Prices

The average value of lumber at the mill has been tabulated annually by the Census Bureau for major species cut in California since 1906. Such average values are much less subject to bias than average stumpage prices and are therefore useful as an index of changes in lumber prices.

On the basis of such data (fig. 8), sugar pine lumber values rose a little faster during the period 1906-1943 than did those of associated species. Comparisons of 5-year average values for the periods 1906-1910 with those for 1939-1943 showed an increase of 98 percent for sugar pine, 89 percent for ponderosa pine, and 92 percent for white fir.

The pattern of price movements was much the same for all three species. All three rose rapidly from 1916 to 1920 and then declined more slowly until 1933. During the 1920-1935 period sugar pine values were better maintained than were those of the associated woods. By 1935, sugar pine was still almost 75 percent above its pre-war value. Ponderosa pine was up only about a third and white fir a quarter.

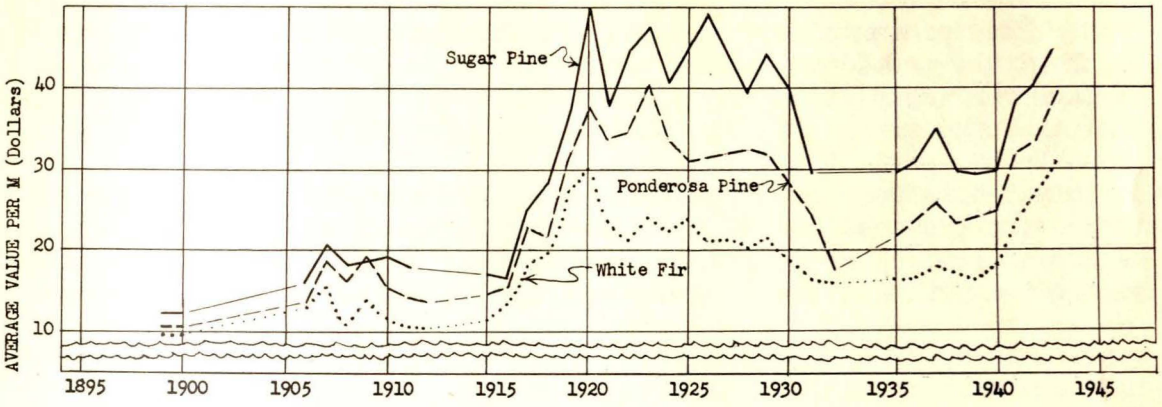



FIGURE 8. AVERAGE VALUE AT MILL OF SUGAR PINE, PONDEROSA PINE AND WHITE FIR LUMBER IN CALIFORNIA, 1899 to 1943.

However, the price rise following 1939 affected the latter two species more strongly than it did sugar pine, so that by 1943 pre-World War I value relationships between the three species had almost been restored.

Lumber value differentials between sugar pine and other species showed significant movements from 1906 to 1943. The average value of ponderosa pine lumber declined from about 90 percent of sugar pine value in 1906 to about 65 percent in 1925. Since the latter year the trend has been toward a narrowing differential between the two species. During World War II ponderosa pine values held steady at about 85 percent of sugar pine lumber values. Differentials between white fir and sugar pine declined still more sharply in the 1906-1925 period. White fir values were about 80 percent of sugar pine values in 1906, but declined to less than 45 percent by 1925. Since then the differential has displayed the same upward trend shown by ponderosa pine. During the war the average value of white fir lumber had recovered to almost 70 percent of that of sugar pine.

The lumber value differentials display somewhat the same trends as did the stumpage value differentials. The principal difference is that white fir stumpage prices tend to bear a much smaller ratio to sugar pine stumpage prices than do lumber values of the two species. This is easily explained on the basis of the residual character of stumpage values. It probably means that further increases in the general level of stumpage prices will lead to a narrowing of the percentage differential between fir stumpage and pine stumpage, even though lumber prices of the various species retain their present relative positions.

## The Long Run Outlook for Stumpage Prices

The opinion of sugar pine producers and of others well informed in the field provides the best guide to the long run price and market outlook for sugar pine. A recent sampling of such opinion showed agreement that the trend of real prices of upper grades of sugar pine will probably be upward for a long time to come. The operators also anticipated increases in the real price of common grades, although these were expected to be less than the increases for clear lumber. It is expected that, grade for grade, prices of sugar pine uppers will rise more rapidly than those of the associated species.

Extension of the long run trends of real lumber values discussed in the preceding section would support this consensus of industry opinion.

Operators also expected a continued general rise in stumpage prices. There was a diversity of opinion as to whether sugar pine would rise more rapidly, at about the same rate, or less rapidly than other species. Others felt that, as virgin timber is cut out, sugar pine would lose some of its present price advantage over other species because of a general reduction in the quality of stumpage.

The historical stumpage price data previously cited provide good evidence in support of this anticipated further increase. They also suggest that the question of changes in stumpage price differentials between sugar pine and associated species may be of little practical importance because of the very slow rate at which such changes have taken place in the past.

On the basis of this evidence, it seems reasonable to conclude that the future price relationships involved in growing sugar pine may be more favorable than those which prevail at present. It suggests that, by the time managed stands of young sugar pine mature, returns will be sufficiently high to offset management costs substantially above those which would appear justifiable in the light of current stumpage returns.

## The Cost Elements in Growing Sugar Pine

Detailed records of costs of growing sugar pine, based on proven silvicultural practice are not yet available. But the weight of past experience indicates that careful treatment is essential if a crop of sugar pine is to be established, protected from natural hazards, and carried through to maturity. Intensive management must go hand in hand with intensive protection against blister rust if satisfactory sugar pine yields are to be obtained at reasonable cost.

Management Costs

In contrast with management of other species competing for the site, sugar pine management may prove more expensive both because of greater difficulty in securing satisfactory regeneration, and because of the need for additional cultural measures.

Where seed trees are used, sugar pine regeneration may be more costly than that of either ponderosa pine or the firs because seed trees must be larger, with consequent greater carrying charges. In addition, for adequate stocking of an area of given size, more sugar pine seed trees must be left because fewer seeds are borne per tree, seed flight range is shorter, and a smaller proportion of seed escapes natural hazards to germination. Planting with sugar pine is also likely to be more expensive than planting with ponderosa pine because of greater costs of seed and planting stock, and of lower field survival. Additional expenditures will probably be necessary to protect sugar pine seed from squirrels and other rodents, which display a preference for sugar pine seed.

Where sugar pine is associated with white fir, young sugar pines will have to be released from competition to insure retention of sugar pine in the stand until time of harvest. Because sugar pine height growth is less rapid than that of white fir, two extra thinnings will probably be required to maintain sugar pines in a dominant position until they are mature.

Even in well-stocked stands, sugar pine clears its trunk of branches by self-pruning only after a long period of time. As the value premium from sugar pine is largely based on the production of Shop and Select grades of lumber, pruning is essential in order to secure a reasonable proportion of knot-free lumber at maturity. Unless pruning is done, the other extra expenditures involved in establishing and protecting the species will be largely wasted in the production of common boards. We have already seen that common grades of sugar pine are unlikely to command any value premium over comparable grades of ponderosa pine, which can be grown at much less expense.

The Impact of Blister Rust Control Costs

Before the war, the cost of ribes eradication, although variable, averaged from four to five dollars per acre. But since 1940 increasing wages and price levels, shorter work weeks and operating seasons, generally lower quality and less productive labor, and higher standards of camp construction, sanitation, and equipment have all tended to increase costs. By 1946, the average cost of ribes eradication in California was almost $16 per acre worked. p. 7 gives $19 for 1946.

But the behaviour of blister rust control costs cannot readily be grasped in terms of broad averages. Any disturbance to the ground, such as logging or fire, causes a large and immediate increase in the ribes population, the size and persistence of which vary with the site and other factors. Thus, all areas under forest management suffer disturbances from time to time which result in ribes regeneration and require intensive ribes suppression work. Costs for any given area will depend on the number, timing, and severity of such fire and logging disturbances, and on local biological factors such as site and type, which condition the ribes response.

For a given forest type, site, and total timber stocking, the costs per acre of blister rust control are largely independent of the amount of sugar pine which is present. Thus, total control costs will be about the same regardless of whether the stand contains 5 percent or 50 percent sugar pine if other conditions are identical. As the entire cost of control must be charged to the sugar pine yield, it is apparent that the degree of sugar pine stocking will have a profound effect on the cost per thousand board feet of sugar pine production.

Moreover, opportunities for reducing unit costs by increasing the percentage of sugar pine in the stand are distinctly limited by the silvical possibilities of the forest types in which sugar pine occurs. Although it is possible that with intensive management practices the sugar pine component may be raised above 35 percent of the total stand, without intensive management the proportion of sugar pine will undoubtedly be much less.

Some idea of the significance of this factor for economical sugar pine production can be gained from the following illustration. A rough estimate indicates that for high site sugar pine—fir areas, a cash outlay of about $55 per acre (at current levels of cost) may be required for blister rust control measures over a 100 year period of converting the old-growth stand into a managed growing stock. This expenditure will, of course, be spread over several decades. A considerable part of it may well be considered as a permanent investment in land improvement and not subject to depreciation. But a substantial proportion still must ultimately be charged to the new sugar pine crop. Total yields from such an area may approach 55 M board feet per acre if adequate stocking has been maintained. If only 35 percent of this yield is likely to be sugar pine, the cash outlay for blister rust control will represent $2.85 per M of sugar pine produced.

Most of the existing cutover area in sugar pine types shows much less than 35 percent sugar pine. Detailed statistics are lacking at present, but on many extensive areas in cutover sugar pine type sugar pine stocking is known to average less than 10 percent of total stocking. If only 10 percent of the total yield were to be realized in the form of sugar pine, the cash outlay for blister rust control would be increased to $10 per M of sugar pine produced.

Similarly, stocking will have a direct effect on unit costs. The blister rust control charge per M will be much greater in a stand that is only half stocked than in one that is fully stocked. Here the effect of reduced stocking on costs per M is intensified by the fact that blister rust control is generally more difficult to achieve in stands where the timber canopy is not complete. Openings in the forest provide favorable conditions for establishment and growth of ribes bushes and insofar as low stocking implies the presence of such openings, per-acre control costs are likely to be significantly higher than in fully stocked stands. Per-M costs of blister rust control in understocked stands are therefore likely to be pyramided, higher per-acre charges being incurred on top of the smaller per-acre volumes over which charges can be spread.

Site has two opposed effects on costs. Yields rise rapidly with increases in site quality. Costs can therefore be spread over a larger volume on high sites, and per-M costs will tend to be lower. On the other hand, high site favors the growth of ribes and total costs on such areas are likely to be higher than on low sites. The effect of site variation on costs per M will thus depend on the particular yield and ribes growth at each local situation.

Differences in forest type also have two mutually offsetting effects. As has already been shown, ponderosa pine normally brings 75 percent or more of the stumpage return obtained from sugar pine, while true firs bring only about 25 percent as much. This suggests that blister rust control can be undertaken more advantageously in those timber types where fir is the alternative to sugar pine than it can in types where ponderosa pine is the alternative. This is so because the alternative to growing sugar pine in sugar pine--ponderosa pine types (growing more ponderosa pine) is more attractive than the alternative available in sugar pine--fir types (growing more low-value firs). But this differential is offset, at least in part, by the fact that total control costs are likely to be much less in sugar pine--ponderosa pine types than in sugar pine--fir types.

The preceding discussion emphasizes the fact that costs of blister rust control and sugar pine management behave in a very complex fashion in response to differences in forest conditions. Decisions as to where sugar pine culture is economically justified must therefore be based on a careful study of behaviour of costs under the variety of site, composition, density conditions, and management methods that are encountered in the woods.

## Summary

A preliminary study of economic aspects of blister rust control and sugar pine management, based largely on existing and readily available data, yields the following information.

1. The sugar pine resource in California consists of some 3.1 million acres of land in sugar pine types, plus an additional 2.2 million acres in other types containing some sugar pine. The area is almost equally divided between public and private ownership. About 800 thousand acres of sugar pine type is on high site land (site I-175 or better), almost all of it in the western Sierra Nevada. The total sugar pine timber stand in California amounts to 21 billion board feet of which about 17-1/2 billion is considered available for commercial use. Fifty-six percent of this volume is in public ownership. Over three-fourths of the available sugar pine is in old growth stands, with only 1.5 percent of the total supply in the form of young growth stands.

2. Since 1933, protection of this resource from blister rust has been carried on on a large scale under the leadership of the Office of Blister Rust Control, in cooperation with numerous Federal, State, and private agencies. At present 2.0 million acres of sugar pine type are included in blister rust control areas, and initial eradication of ribes has been completed on 39 percent of that acreage. Control effort has been concentrated in the optimum range of sugar pine occurrence. Work done to date represents about 27 percent of that estimated as necessary to secure and maintain control by present methods on areas now included in control units. Average costs in 1946 amounted to about $16 per acre worked, some three times pre-war levels of cost. The increase was due largely to increased costs of labor and materials and lower levels of worker productivity. New methods of ribes suppression hold some promise, however, for future reductions in cost.

3. Sugar pine consumption in the United States averaged 256 million feet b. m. from 1927 to 1945. A peak of 400 million feet was achieved in 1942 and current use is well above the 19-year average. About one-third of this total is ordinarily used for specialty purposes including sash, doors, millwork, patterns, and other forms of manufacture. The remainder goes largely into box manufacture and light construction uses. Market dependence on sugar pine is clear cut for pattern making and boot and shoe findings, certain types of instruments, and shade and map rollers. In sugar pine producing states, in the Lake States, and in the Northeast the species is a major source of supply for sash, door, and millwork plants. Elsewhere, and in other uses, sugar pine is a very minor element in total softwood lumber supply. The future trend of sugar pine lumber requirements will be the resultant of several conflicting factors. As nearly as these can be appraised at present, minimum total future requirements should not be far different from the quarter of a billion board foot average annual consumption of the past two decades. Of this, some 75 million board feet of output will be required annually to meet needs of high priority manufacturing uses.

4. Sugar pine stumpage values displayed a general upward trend from 1910 to 1945 amounting to an increase of roughly 1 percent

per year. The differential between sugar pine values and those of other species has shown little significant change. Ponderosa pine stumpage values were about 75 percent those of sugar pine during the 1940-1945 period. White fir values were less than 20 percent of sugar pine values. Available evidence points to a continued, and possibly more rapid, long run rise in relative sugar pine stumpage values, as supplies of high grade wood become increasingly scarce. Because stumpage values currently amount to less than 15 percent of lumber values at the mill, stumpage prices could increase two- or three-fold without leading to prohibitive rises in the average value of sugar pine lumber. Hence, the anticipated rise in stumpage values should not have major adverse effects on markets for sugar pine lumber.

5. The costs of sugar pine protection and management, per M board foot produced, are extremely sensitive to variations in site quality, stand composition and density, and age of stand. They are too variable to permit of any ready generalizations. Ultimate determination of the margin for economical sugar pine production and blister rust control will depend on careful study of the way in which control costs vary as between the different stand conditions encountered in the sugar pine zone. When the market and price data presented in this report are supplemented by the results of such cost studies, a sound basis will be available for defining sugar pine management units on economic grounds.